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FOOD HABITS OF THE COYOTE IN JACKSON HOLE, WYO.

By OLAUS J. MURIE, *biologist, Division of Wildlife Research*
Bureau of Biological Survey

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INTRODUCTION

When the outline was made of a proposed study of the Jackson Hole elk, to be initiated by the Bureau of Biological Survey in the summer of 1927, an important problem to be solved was the relation between the elk and predatory animals. To the writer was assigned the task of obtaining detailed information on the subject. Early in the study it was evident that the only predators involved to any extent were coyotes and bears. Efforts were concentrated on the study of the coyote, as the chief natural enemy of the elk in this section, and the present report is the result of investigations over a period of about 4 years.¹

TERRITORY COVERED

The territory covered by this investigation included the foothills from Horse Creek, south of Jackson, Wyo., along the east side of Jackson Hole northward to Buffalo Fork; and the mountainous area comprised in the present Teton State Game Preserve, from lower Jackson Lake and Buffalo Fork north to the southern part of Yellowstone Park, and from Arizona Creek on the west to the Upper Yellowstone and Thorofare Creek on the east. By far the greater part of the material was collected on the Teton Game Preserve. Only a few samples were taken along the foothills east of Jackson Hole. While the number of stomachs obtained from Yellowstone Park is far too small to be representative of the park by itself, the general

¹ The cooperation is gratefully acknowledged of many individuals who assisted materially during the course of this study. Special mention should be made of the assistance of Roger W. Toll, superintendent of the Yellowstone National Park; William M. Rush and various park rangers, who supplied coyote stomachs from the park; A. C. McCain, supervisor of Teton National Forest, who consistently helped with facilities in the field as well as with data on the wildlife of the section, based on information in the files of the Forest Service; Frederick M. Gaige and his associates in the Museum of Zoology of the University of Michigan, at Ann Arbor, who kindly identified invertebrates for the reference collection; and Adolph Murie, then of the same institution, who gave effective field assistance on several occasions.

area is similar, and when included in the whole collection, the data may be considered adequate.

The area represented is essentially of wilderness type. The interests involved are concerned with game and recreation, and to some extent with cattle, but there were no domestic sheep on the public ranges covered. No intensive coyote control has ever been conducted by the Biological Survey in this section. In 1923, at the urgent request of members of the Jackson Hole Cattle and Horse Association, which had previously paid high bounties in an effort to eliminate wolves, the Bureau assigned hunters to the Jackson Hole section to capture these predators. Periodically one and sometimes two men were stationed there until 1927, when all control work by the Federal Government in the area was discontinued. Incidental to the work of capturing wolves, some coyotes were taken with traps and some by placing poison where it was considered that its exposure would not endanger other species. Local residents have always trapped, shot, and, to a limited extent, poisoned coyotes, and their work has constituted the only control since the last Biological Survey hunter was removed in 1927, the year these investigations began.

SCOPE OF THE WORK

No attempt is here made to include an account of the general fauna and flora of the area under consideration. Completeness is not claimed. It seems worth while, however, to consider the general ecological relationships of the various species affected by coyotes, devoting special attention to the elk. The fact that most of the material was collected on the Teton State Game Preserve gives special emphasis to the principal calving grounds of the elk, and thus makes a severe test of the coyote's relations to the elk. Had the study been confined to the more southerly parts of the Jackson Hole section, the elk question would scarcely have arisen.

On the other hand, it must be made clear that two other species preyed upon by the coyote are not adequately represented in these findings. Mountain sheep occur in parts of the area covered, but time did not permit intensive collecting work on their ranges. Some data were gathered, and these will be discussed, but more information is required. Mule deer likewise occur in the area intensively worked over, though they are perhaps not plentiful enough for final conclusions to be drawn regarding the effect of coyotes upon them.

TECHNIC

The general field observations made were supplemented by detailed analyses of the contents of stomachs and feces of coyotes. Though 64 stomachs were obtained, principally from park rangers of the Yellowstone National Park, and the contents listed, the data rest chiefly on the study of feces, 714 samples of which were collected throughout the area during the 4 years, each sample being labeled as to locality, date, and approximate age.

In a study of this kind certain precautions have to be taken and kept in mind. First, identification must be certain. Feces of coyotes vary greatly in size and shape, depending on the type of food represented. Great care is necessary in such work, particularly in localities

where the presence of other species may complicate identification. In Jackson Hole the matter was relatively simple.

Another safeguard taken was to insure that the material was representative. The practice was followed of collecting every sample found, and of discarding none whatever when identification was certain. A few samples in the doubtful class were discarded without examination, and a few others were discarded only when the contained material could not be determined. Aside from these few instances, the collection is representative and large enough to be significant. Particular care has been given to this matter, since having representative material available is most important to the formulation of conclusions.

When collected, the feces were wrapped in a piece of cheesecloth and labeled. Later the samples were placed in turn in a container with a fine screen bottom and thoroughly washed and dried. The material could then be readily identified, though analyses at the field headquarters were not so minute as would have been the case with ample laboratory facilities and time.

The conservative practice was followed of recording as the number of individuals of each species in one sample only as many individuals of that species as could be certainly identified in it, even though it appeared, but could not be demonstrated, that more were present. This number was determined by the elements most plentiful. For instance, 2 pairs of upper incisors of pocket gophers would indicate at least 2 of these rodents in a given sample; or 3 right humeri of field mice would represent a minimum of 3 mice, although the mass of fur present might suggest a greater number. The greatest number that could be recognized without doubt was recorded, therefore, as representing the minimum number of individuals actually present. In a number of instances, when the quantity of fur indicated 2 or more individuals, but only 1 tooth or 1 pair of teeth or only 1 diagnostic bone could be found, only 1 individual was recorded. It is felt that lack of such detailed precision does not affect the results in any important degree. The samples were carefully examined, and though for any given species of the smaller mammals the total number of individuals present was probably somewhat greater than the number listed, the discrepancy was very small.

In many cases no attempt was made to determine the subspecies when several occur in the locality. Subspecific determinations of *Microtus*, for instance, based on scattered teeth and other skeletal remains, would be more time-consuming than was considered necessary. When only one variety occurs in a locality, that subspecies is listed.

When only a certain type of residue is present in the feces, it is impracticable to employ volume or weight as the unit of measure. The number of individuals has, therefore, been used as the best unit for the calculations from this study, and the percentages here given are based, therefore, on the individual items in the food and not on its bulk.

Droppings collected represent all seasons of the year. Care was taken to estimate as nearly as possible the age of the sample collected, but often the time could not be determined more closely than "winter" or "summer." Since many coyotes migrate in winter from the more northerly areas of Jackson Hole, the parts where the work was largely

carried on, no doubt the summer droppings are somewhat better represented than those of winter, but since all feces found were collected in all possible situations, the results presented form a fair cross section of the year-long food habits of the coyote in Jackson Hole.

In the light of local conditions the writer desires to contrast the values of the stomachs and the feces used in the study. Examination of contents of stomachs from Yellowstone Park and of the data furnished for each revealed too great a preponderance of bait and carrion to give a true picture of coyote habits. It was a common practice of park rangers to shoot coyotes over bait, such as the carcass of a horse or other handy material, and coyotes obtained in this manner are likely to furnish evidence of carrion diet. It was evident that some coyotes had been feeding on offal from the bison annually slaughtered, and some evidently had had access to garbage piles. For this reason, in making deductions, less reliance was placed on the stomachs than on the feces, which were collected at random over the general coyote range of this section.

FOOD ITEMS IDENTIFIED

The items comprising the food of the coyote in Jackson Hole are listed in table 1 in the order of their popularity, as shown by the numbers (not bulk) of each in the stomachs and feces. As a basis for evaluating the effects of the coyote's feeding habits in Jackson Hole, each kind of food found to be on the animal's bill of fare is treated separately, in systematic order, in the pages that follow. Because of the economic factors involved, each is considered in its ecological position.

On the data thus developed, the items can be classified as to economic importance, though it is usually difficult to distinguish clearly those that indicate harmful, beneficial, or neutral food habits. This is because an animal that is preyed upon may be economically harmful in one locality and neutral or beneficial in another. The snowshoe hare, for instance, which is considered game in some districts, would there be entered on the debit side against the coyote, while in others it would be listed either as of neutral economic status, or as harmful, because of its destructiveness to vegetation. Similarly, it might be urged with some reason that in areas where field mice have no opportunity to menace agriculture, these rodents should be considered a neutral item in the coyote diet. On the other hand, in view of the uncertainty as to what constitutes a check on rodent species, and in view of the potential harm of field mice when too numerous, it seems best to credit the coyote for including them in its diet. The beneficial percentage is of less importance here, however, than it would be in a strictly agricultural area.

The 778 stomachs and feces examined contained 2,415 separate items. Of these, the 1,629 noncarrion items representing mammals and birds have chief economic significance in the Jackson Hole country. Of the 24 species of mammals and birds preyed upon by the coyotes of this section, 6 may be held to indicate economically beneficial food habits, 10 neutral, and 8 harmful. On the basis of the 1,629 bird and mammal food items, 70.29 percent are in the

TABLE 1.—Classification of 2,415 individual food items found in 64 stomachs and 714 feces of coyotes in Jackson Hole, Wyo., listed in the order of occurrence of items identified¹

Species and groups	Occurrences			
	Noncarrion		Carrion	
	Number	Percent ²	Number	Percent ²
Mammals:				
Field mouse (<i>Microtus</i> species).....	504	20.87		
Pocket gopher (<i>Thomomys fuscus</i>).....	379	15.69		
Snowshoe hare (<i>Lepus bairdii bairdii</i>).....	167	6.92		
Golden-mantled marmot (<i>Marmota flaviventris nosophora</i>).....	150	6.21		
Elk (<i>Cervus canadensis</i>), adult.....			80	3.32
Young.....	76	3.15	6	.25
Rocky Mountain jumping mouse (<i>Zapus princeps</i>).....	96	3.98		
Porcupine (<i>Erethizon epixanthum epixanthum</i>).....	78	3.23		
Horse.....			27	1.12
Uinta ground squirrel (<i>Citellus armatus</i>).....	24	.99		
Mule deer (<i>Odocoileus hemionus macrotis</i>).....	20	.83		
Beaver (<i>Castor missouriensis</i>).....	12	.50		
Coyote (<i>Canis lestes</i>).....			12	.50
White-tailed jack rabbit (<i>Lepus townsendi campanius</i>).....	10	.41		
Buffalo (<i>Bison bison bison</i>).....			10	.41
Deer mouse (<i>Peromyscus maniculatus osgoodi</i>).....	8	.33		
Chipmunk (<i>Eutamias</i> species).....	8	.33		
Domestic cattle.....			1	.04
Golden-mantled ground squirrel (<i>Callospermophilus</i> species).....	7	.29		
Pine squirrel (<i>Sciurus hudsonicus ventorum</i>).....	6	.25		
Moose (<i>Alces americana shirasi</i>).....			5	.21
Muskrat (<i>Ondatra zibethicus osoyoosensis</i>).....	4	.17		
Antelope (<i>Antilocapra americana</i>).....			3	.12
Bushy-tailed wood rat (<i>Neotoma</i> species).....	2	.08		
Rocky Mountain marten (<i>Martes caurina origines</i>).....	2	.08		
Black bear (<i>Euarctos americanus</i>).....			2	.08
Mountain sheep (<i>Ovis canadensis</i>).....	1	.04		
Flying squirrel (<i>Glaucomys sabrinus bangsi</i>).....	1	.04		
Dwarf weasel (<i>Mustela cicognanii leptus</i>).....	1	.04		
Total.....	1,556	64.43	146	6.05
Birds:				
Small birds.....	36	1.50		
Egg.....	1	.04		
Richardson's grouse (<i>Dendragapus obscurus richardsoni</i>), adult.....	3	.12		
Young.....	3	.12		
Gray ruffed grouse (<i>Bonasa umbellus umbelloides</i>), adult.....	3	.12		
Egg.....	1	.04		
Grouse (species undetermined), adult.....	11	.46		
Eggs.....	13	.54		
Ducks (species undetermined).....			7	.30
Eared grebe (<i>Colymbus nigricollis californicus</i>).....			3	.12
Magpie (<i>Pica pica hudsonia</i>).....			2	.08
Rocky Mountain jay (<i>Perisoreus canadensis capitalis</i>).....	1	.04		
Domestic poultry.....			1	.04
Wild bird (species undetermined), egg.....	1	.04		
Total.....	73	3.02	13	.54
Fishes: Trout (<i>Salmo</i> species).....			17	.70
Invertebrates:				
Grasshoppers (2 mole crickets) (Orthoptera).....	507	20.99		
Beetles (Coleoptera).....	66	2.74		
Bumble bee and ant (Hymenoptera).....	2	.08		
Flies (1 <i>Cuterebra</i> species) (Diptera).....	2	.08		
Snail (Gastropoda).....	2	.08		
Total.....	579	23.97		
Vegetable matter:				
Grass (Gramineae).....	20	.83		
Pine nuts (<i>Pinus albicaulis</i>).....	9	.38		
Serviceberry (<i>Amelanchier</i> species).....	2	.08		
Total.....	31	1.29		
Total food items.....	2,239	92.71	176	7.29

¹ In addition, miscellaneous nonfood items occurred as follows: Cloth (4 times), button (1), paper (1), wood (1), and harness leather with rivet (1).² Based not on bulk, but on total number of food items (2,415).

beneficial class, 18.22 percent are neutral, and only 11.49 percent are harmful. This leaves out of the consideration for this section the invertebrate and vegetable food, the 611 items of which are there of little if any economic significance. The classification of the food on the economic basis, as here considered, is shown in table 2.

TABLE 2.—*Economic evaluation of mammal and bird consumption by coyotes in Jackson Hole, Wyo., based on examination of the contents of 64 stomachs and 714 feces, exclusive of carrion items*

Food items	Occurrence ¹	Proportion of bird and mammal items (1,629) ¹	Food items	Occurrence ¹	Proportion of bird and mammal items (1,629) ¹
Beneficial (6 species):	Number	Percent ²	Neutral—Continued	Number	Percent ²
Golden-mantled marmot.....	150	9.21	Snowshoe hare.....	167	10.25
Uinta ground squirrel.....	24	1.47	Rocky Mountain jay.....	1	.06
Pocket gopher.....	379	23.27	Total.....	297	18.22
Field mouse.....	504	30.94	Harmful (8 species):		
Porcupine.....	78	4.79	Rocky Mountain marten.....	2	.12
White-tailed jack rabbit.....	10	.61	Beaver.....	12	.74
Total.....	1,145	70.29	Muskrat.....	4	.25
Neutral (10 species):			Elk (calves).....	76	4.67
Dwarf weasel.....	1	.06	Mule deer.....	20	1.23
Golden-mantled ground squirrel.....	7	.43	Mountain sheep.....	1	.06
Chipmunk.....	8	.49	Birds (small, unidentified).....	33	2.33
Pine squirrel.....	6	.37	Grouse.....	34	2.69
Flying squirrel.....	1	.06	Total.....	187	11.49
Deer mouse.....	8	.49	Grand total.....	1,629	100.00
Bushy-tailed wood rat.....	2	.12			
Rocky Mountain jumping mouse.....	96	5.89			

¹ Exclusive of carrion.

² Based not on bulk, but on numbers of food items.

MAMMALS

BLACK BEAR

Two coyote stomachs from Yellowstone Park contained a claw and some hair of a black bear (*Euarctos americanus*), together with other miscellaneous items, including porcupine quills and marmot and elk hair. This was clearly carrion, probably obtained from a garbage dump. The only significance of this item is that it shows the readiness of the coyote to feed on bear flesh when opportunity offers.

ROCKY MOUNTAIN MARTEN

Two fecal samples contained remains of a Rocky Mountain marten (*Martes caurina origines*). These could have been carrion, though the writer has seen martens under circumstances that would have permitted their capture by a coyote. Such occasions, however, would be rare.

DWARF WEASEL

The single occurrence of the dwarf weasel (*Mustela cicognanii leptus*) indicates that this agile species probably seldom falls prey to the coyote.

COYOTE

In 12 instances remains of coyotes (*Canis lestes*) were found. Of the stomachs examined one indicated that the trapped animal had eaten bait, consisting of a coyote foot, together with chicken and goose feet and other garbage. The other stomachs, from shot coyotes, and several feces indicated clearly that coyote carcasses had served as food, although in some other cases the coyote hair present might have been of accidental occurrence. There is enough evidence, however, to show that coyotes do not hesitate to eat their own kind as carrion. A Yellowstone Park ranger informed the writer that he had frequently noted them feeding on coyote carcasses thrown out after skinning.

GOLDEN-MANTLED MARMOT

The material collected shows 150 golden-mantled marmots (*Marmota flaviventris nosophora*) eaten by coyotes, representing 6.21 percent of the items in the diet (after deducting two occurrences that appeared to be duplications). Throughout the area marmots are locally plentiful, particularly in the more rocky parts, although many sections are not suitable for them.

The marmot is not strictly an economic factor in most of the Jackson Hole section. Though fields adjacent to rocky slopes pay toll to its foraging activities, in mountainous parts the rodent's only competitors for forage are the game animals, and at present their competition is negligible. Whether the marmot is likely to become a pest in this section is doubtful.

Available data are insufficient to indicate to what degree the coyote constitutes a local check on the marmot. The golden eagle has been found to prey on this species more or less constantly, but eagles are scarce in the area and it is not certain that any species there preys regularly on it.

Presumably, then, the coyote should be welcomed as a possible check on undue increase of marmots. Viewed from another angle, however, the presence of these rodents acts as a safety valve, tending to keep the food habits of the coyote in safe channels.

GOLDEN-MANTLED GROUND SQUIRREL.

Remains of the golden-mantled ground squirrel (*Callospermophilus lateralis* subsp.) appeared only seven times in the coyote droppings. This can be explained by the scarcity of this species in the region investigated. In fact it was a matter of surprise to find as many as seven represented in the coyote diet, for only occasionally, in favorable rock masses, can one find these animals, and then in limited numbers. In this particular area the golden-mantled ground squirrel presents no problem, and its presence in the coyote diet has little significance, beneficial or otherwise. In other sections of the country the situation might be different.

UINTA GROUND SQUIRREL

Twenty-four Uinta ground squirrels (*Citellus armatus*) were represented, making 0.99 percent of the items in the coyote diet. This animal occurs in Jackson Hole proper and in some of the tributary valleys. As a rule, it does not occupy the strictly mountainous areas, the exceptions being certain extensive meadow lands, such as lower Pacific Creek and parts of the Gros Ventre basin. It is not plentiful at the outer fringes of its range, but becomes numerous in Jackson Hole where it is subject to the usual rodent cycles and is a nuisance in agricultural localities. The coyote inhabits the mountains in summer and is comparatively rare in the valley. It descends to the lowlands principally in winter, when this ground squirrel is in hibernation. Therefore it is only in the lower foothills, along the edges of the more open country, that the coyote has opportunity to prey on this rodent. The 24 ground squirrels represented were obtained principally in the vicinity of Jackson and neighboring points. Had collecting activities extended as far south as the Hoback Basin, or to certain localities in Yellowstone Park, the results might be somewhat different. Considering the territory in question and the present distribution of coyotes, however, the ground squirrel is in several respects a beneficial item of the diet, but its frequency is not sufficient to be considered as constituting effective control.

CHIPMUNK

The chipmunk (*Eutamias* sp.) appeared only eight times in the food examined. Chipmunks are plentiful throughout the mountains, and the low percentage (0.33) of its occurrence is probably a tribute to its alertness and agility. The coyote doubtless spends most of its time on easier game. So far as can be determined the chipmunk presents no economic problem in these forested areas and its value in the coyote's diet must be noted as neutral.

RED, OR PINE, SQUIRREL

The coyote probably rarely has opportunity to obtain a red, or pine, squirrel (*Sciurus hudsonicus ventorum*), and remains of this rodent appeared only six times in the food samples. Its value is considered neutral in the coyote's diet.

FLYING SQUIRREL

The flying squirrel (*Glaucomys sabrinus bangsi*), evidently a rare item in the coyote's diet, occurred only once. Considering the scarcity of flying squirrels, preying on them might be deemed harmful, but from the limited occurrence it is better to list this item as neutral.

POCKET GOPHER

The pocket gopher (*Thomomys fuscus*), appearing 379 times, 15.69 percent of the food items examined, ranks second in the coyote diet. Although the writer has begun a detailed study of the pocket gopher as an element of the fauna of the Jackson Hole section, it is too early to state the extent to which this species is injurious there. No agricultural activities are involved except in limited areas in the southern part of Jackson Hole, which lie outside the field of this investigation.

Livestock grazing is limited, and the pocket gopher's only real competition for food is with game, the supply of forage available to big game, particularly the elk, being somewhat reduced by pocket gophers. It was noted that the rodent is fond of tall larkspur, a plant poisonous to livestock, but larkspur still appears to thrive, and elsewhere would be a menace to grazing.

It is difficult to determine the possible value of the pocket gopher as a cultivator of the soil, and lack of time has hindered any detailed attempt to study the problem in this locality. Although not based on experimental study, observations indicate that the pocket gopher is not here a factor in erosion. Differences in the vegetative cover appear rather due to age and composition of the soil and other physical factors than to the rodent.

The whole question of the ecological status of the pocket gopher in areas such as the one here considered requires special study, with evaluation of the factors with reference to all public interests. It should be pointed out that in some localities the pocket gophers furnish a food for carnivores and birds of prey, to that extent permitting their existence without undue drain on the numbers of less abundant species. This vital factor in the general wildlife situation should not be overlooked.

The investigations have not sufficiently progressed to hazard even an opinion as to whether the coyote, in its present numbers, can keep the pocket gopher from becoming a pest. Certain hawks, the great horned owl, and probably other species also prey on the pocket gopher, and the question arises as to what extent this aggregation of predatory species tends to keep the rodent in check. Naturally the pocket gopher is most available in summer but one stomach that contained 2 field mice and 1 pocket gopher was obtained December 28, showing that the coyote can obtain them even in the snow. The extent to which this practice prevails is not known. The fact remains that in point of numbers the pocket gopher ranks second, next to field mice, in the coyote diet.

The coyote spends much time in the open parks and meadows but its manner of hunting the pocket gopher has not been noted. The animal is swallowed entire, after being chewed a little. As many as 5 and 6 were sometimes represented in a single fecal sample, indicating that the coyote deliberately seeks this rodent as a staple food.

Considering the potential harm to vegetation by too great numbers of pocket gophers, and the general reputation of the rodent at the present time, its inclusion in the diet must be considered beneficial.

BEAVER

Twelve beavers (*Castor canadensis*) were represented in coyote feces. It appears that the whole beaver carcass is eaten, for practically all parts were found, including teeth and claws, and in at least two instances, scales from the tail were present, showing that the coyote does not neglect that delicacy. Apparently it captures the beaver during its wanderings away from water. As in the case of the muskrat, this fur bearer should be listed with the harmful portions of the coyote's diet.

WHITE-FOOTED, OR DEER, MOUSE

The white-footed, or deer, mouse (*Peromyscus maniculatus osgoodi*) is plentiful in suitable places throughout the territory. It is most numerous in broken country of varied topography on forest margins, where it has the benefit of shelter as well as access to the adjacent, more open terrain. Since the coyote hunts largely in the open, where field mice and other kinds of prey are abundant, it has probably focused its attention on those forms, picking up a *Peromyscus* only incidentally. This rodent appeared only eight times in the material examined. The white-footed mouse is also more strictly nocturnal than some of the other species, possibly not occurring so often at the time when the coyote habitually hunts. Some of these explanations may account for its scarcity in the diet. Its presence is not very significant and may be listed as of neutral effect.

BUSHY-TAILED WOOD RAT

The bushy-tailed wood rat (*Neotoma* sp.) appeared only twice in the food examined. In one case there was a fragment of bone, which may have been picked up at a wood rat's nest. In the Jackson Hole section this rodent appears to be harmless, has no economic importance, and is an interesting element of the fauna. It may be considered a neutral item in the coyote's diet.

FIELD MOUSE

Of the material examined, 504 field mice (*Microtus* sp.), representing 20.87 percent of the food items, head the list of species in the coyote's diet. Of this number 11 were definitely identified as the large *Microtus richardsoni macropus*, although it appeared certain that many more of this species were present. No particular effort was made, however, to distinguish the various forms of field mice.

Throughout this section the coyote is almost universally spoken of as a mouser, and the large percentage of field mice eaten is in keeping with its observed habits. The predator is generally met with in mountain meadows, where both field mice and pocket gophers normally occur. Coyote droppings were found most plentifully in the vicinity of meadows, rarely in the deeper woods. On one occasion a rancher reported having seen a coyote catch six mice, before he shot it for the hide. Upon examination the stomach was found to contain the six mice, together with some carrion.

As many as 5 to 10 field mice were represented in single fecal samples. It is clear, from all information available, that field mice and pocket gophers constitute the principal part of the coyote's diet in this section, and that these rodents are among the factors vital enough to mold the animal's hunting habits. The mice are eaten the year round, but no doubt are much more available in summer.

Diurnal to a considerable extent, field mice may often be seen scurrying through the grass, and the big-footed field mouse (*macropus*) has been found and photographed while the sun was bright. This, together with the fact that these mice are rather easily caught by pouncing, may have much to do with the coyote's hunting preference, to the exclusion of some other mice.

The field mouse is a staple article of diet for many species of birds of prey and carnivores, including valuable fur-bearing animals, and

as such has an important place in any game country or wildlife sanctuary. Where mice are absent, other species will be preyed upon, with the result that in many areas that have been too well cleaned up, a number of birds and mammals become "vermin" to certain interests. It must be remembered that field mice are commonly subject to extreme fluctuation in numbers and locally may become a pest, hence repression through the agency of wild creatures is highly desirable. Whether the depredations on field mice of all birds and mammals combined are an important factor in control is unknown. But to the extent that this is the case the coyote would hold high rank. All things considered, it may be stated that the coyote's habit of preying on field mice here must be listed as beneficial, though it must be remembered that the area is essentially a mountainous game country.

MUSKRAT

That muskrats (*Ondatra zibethicus osoyoosensis*) appeared four times bears little significance, and it is evident that the coyote rarely captures one. No portions of the area here considered are typical muskrat habitat with the exception of a swamp near Jackson. Elsewhere the muskrat is sparingly distributed. Although the coyote does not apparently obtain any great number, in view of the fur value of the muskrat this item in the diet should be listed as harmful.

ROCKY MOUNTAIN JUMPING MOUSE

Rocky Mountain jumping mice (*Zapus princeps*), numbering 96, formed 3.98 percent of the items in the coyote diet. This is what one would expect. These mice are locally plentiful, are frequently seen throughout the day, and are easily caught, although they have a disconcerting habit of stopping suddenly after a series of long jumps, giving the illusion of disappearance. They are common in the open areas, where the coyote spends much of its time. As it seems unlikely that the jumping mouse would become of economic importance, it is here considered a neutral item in the coyote's diet.

PORCUPINE

Parts of 78 porcupines (*Erethizon epixanthum epixanthum*) were found in the samples. One of the surprises of the investigation was the importance of the porcupine in the coyote diet and the degree of the predator's immunity to injury from the quills. Trappers and woodsmen in general have known of the coyote's habit of feeding on porcupines, but it was not expected that the porcupine would represent as much as 3.23 percent of the bird and mammal items in the diet. Some of these animals may represent carrion, but it is difficult to obtain data on this point. No doubt a few are killed by travelers and subsequently serve as food for coyotes, and one instance of this was observed. Over much of the Teton Game Preserve and in Yellowstone Park, however, the coyote probably eats very few porcupines as carrion.

Evidence shows that the coyote can kill a porcupine, and it probably does so at every opportunity. A. C. McCain, supervisor of Teton National Forest, relates that a woodsman in whom he had confidence told of watching the process. The porcupine attempted escape by climbing a tree, but the coyote dashed in, seized it in the

under parts, and quickly killed it. O. A. Pendergraft, game warden with headquarters at Jackson, also reports seeing the process. He states that the coyote will stalk around the porcupine, "fooling" with it, sometimes for a long time, until eventually the quarry presents an opening and the alert coyote dashes in and seizes it in an unprotected part. An observation of Charles Hedrick, experienced trapper and close observer, corroborates the method of attack. He reports that in 1896, while crossing Spread Creek on skis, he found an area trampled with coyote tracks, the snow in places being packed hard. He estimated that there had probably been about four of the animals. Presently he spied a dark object on the snow that proved to be a porcupine skin, neatly rolled back, inside out. He back-tracked as well as he could in the maze of trails and found a place where apparently the porcupine had sat curled up, on the defensive, while the coyotes had circled about cautiously. Finally, when the porcupine made a break for cover, he judged that the coyotes had probably found their opportunity and seized it in an unprotected spot.

All these observations have this in common, that the coyote proceeds cautiously and awaits the opportunity to dispatch the porcupine with the least possible harm to itself. This is somewhat of a contrast with the direct methods of the wolverine. The mountain lion also kills porcupines, but its method is not known to the writer. In eating the animal a mountain lion is said to roll back the skin carefully just as the coyote does.

With all its caution, the coyote does not always escape the quills. One carcass examined was found to contain a number of quills embedded in the subcutaneous tissues of the shoulder, and similar instances have been related by trappers. Such quills may have been acquired in the process of killing, but a study of the feces shows that many quills are taken with the food and pass through the alimentary canal. In the 78 samples revealing the remains of porcupines, 43 contained 1 to 6 or more quills, some of which were large, full-sized needles, still sharp when dried. Apparently the coyote ignores a few quills when feeding on porcupines, accepting as food everything but the heavily armored parts of the skin and the tail. In the feces were found remains of all parts of the skeleton (except the tail), including head with teeth and feet with claws, a whole foot with claws having been found several times.

That the coyote does not always fare so well is indicated by an experience related by Forest Ranger Jack Tevebaugh, who was stationed in the Upper Yellowstone in the winter of 1930-31. In the latter part of March he shot a coyote that was extremely emaciated. It was found to be full of porcupine quills, in the skin, in the tissues under the skin, on the head, and even inside the mouth. On the head were two festering sores.

To state the economic significance of the fact that coyotes prey extensively on porcupines is not a simple matter. It would seem that any species that preys more or less persistently on such a slow reproducer must be a factor in checking its increase. The mountain lion is now gone from Jackson Hole, and the wolverine is on the verge of extinction there. The fisher, likewise, is absent, and the lynx rare. This leaves the coyote the only known enemy of the porcupine there at present. In the area under consideration porcupines are rather scarce, though they have several times been reported as plentiful in

certain localities and frequently their old damage to bark is noted. Whether the degree of control exercised by the coyote on the porcupine would be economically beneficial depends on local circumstances. In many places porcupines are considered a pest. The Teton National Forest, however, is less essentially a lumber-producing area than a "game forest" in which recreation holds a prominent position. A moderate number of porcupines may now be considered an asset instead of a timber menace here in view of the fact that part of the forest has recently been made a "primitive area" by the Forest Service. Although it is possible to find trees killed by porcupines, the writer has not noticed extensive or dangerous damage in the area.

On the other hand, if one takes into consideration the fact that porcupines, uncontrolled, could increase to numbers that would make them a distinct menace, then their inclusion in the coyote diet must be considered beneficial. A number of residents remember the time when porcupines were extremely numerous in the Jackson Hole section. Charles Hedrick, quoted above, states that they were numerous in 1896 and that he then saw as many as 7 in one tree. Another trapper remarked that he had seen 10 in one tree. Available data indicate that the species had reached its peak of abundance there at that time. In 1902, when Hedrick hunted over a wide area in the Mount Leidy district, he saw none. They seemed to have entirely disappeared. This is in agreement with the general trend of the available information. As several have expressed it, the porcupines after reaching an unbelievably high peak in numbers, then died off. Hedrick quotes Frank Peterson to the effect that Peterson and Turpin, early settlers, saw the first coyotes in Jackson Hole in 1889. Data on the local distribution of the coyote in primitive times are too meager to say whether their absence or scarcity in early days served as a factor in the unusual abundance of porcupines. Regardless of this, however, it seems certain that porcupines are capable of becoming over plentiful. Therefore, to whatever extent the coyote acts as a check on them, such action must be considered beneficial.

WHITE-TAILED JACK RABBIT

White-tailed jack rabbits (*Lepus townsendi campanius*) appeared 10 times in the material examined, but there is no question that they would have constituted a more important item in the diet had more collecting been done in its range. In the area covered the coyotes had opportunity to obtain jack rabbits in only limited areas along the foothills. The samples obtained were collected mostly near Jackson.

On several occasions tracks of coyotes were noted following those of jack rabbits; and one case clearly showed the chase and capture. Two coyotes had been traveling together, one some distance above the other on an open slope. The lower animal had passed close to a jack rabbit crouching in the snow at the entrance to a badger hole. The rabbit had fled, whereupon the coyote wheeled, giving chase. The two animals made several sharp turns, zigzagging up hill, the coyote failing each time to turn as sharply as the rabbit. After a run of some 60 yards from the badger hole, the rabbit dodged again, but came within reach of the second coyote, which had come racing diagonally down the hill to join the chase. The snow was rather

trampled for reading the record, but it appeared that it was the second coyote that seized the rabbit. One then went off with the rabbit in its mouth, accompanied by its companion.

It is probable that a single coyote might have difficulty in capturing these rodents, but on one occasion a lone coyote that had been feeding on a jack rabbit was shot. The habit of feeding on jack rabbits is decidedly beneficial.

SNOWSHOE HARE

The remains of 167 snowshoe hares (*Lepus bairdii*) were represented in the coyote's diet, ranking third (6.92 percent) in point of numbers. The preponderance of this hare over the jack rabbit is easily explained by the fact that the coyotes of this section inhabit chiefly the mountain areas and that nearly all the food samples were collected in that environment.

The coyote preys upon the snowshoe hare throughout the year, but the majority of occurrences represented animals in the white pelage of winter. No doubt this hare is a staple article of coyote diet at that season. It is of interest to note that snowshoe hares were not abundant during the period of this investigation. How the coyotes could have found so many has been cause for speculation.

This hare appears to be sparingly distributed throughout the area, and there has been no evidence that it is injurious under present conditions. It is notoriously subject to cyclic fluctuations, however, and conditions may easily change. It is doubtful whether the snowshoe hare, even if abundant, would cause serious damage in Jackson Hole. In this section it is not considered a valuable game animal. Its inclusion in the diet should perhaps be considered of neutral importance.

ELK

Since a development of the relationship of the coyote to the elk (*Cervus canadensis*) has been the principal object of this study, considerable attention has been given to the elk items in the coyote diet, those representing adults and young being considered separately.

Adult elk remains, all carrion, were evident in 104 cases, but because single carcasses had been fed upon by several coyotes, these may be held to represent a minimum of 80 individuals. It should be stated that general observations would suggest that this is a very low figure, to be explained by the fact that on the Teton Game Preserve, where a great majority of the droppings were collected in order to cover the elk-calf situation thoroughly, the elk are comparatively scarce in an ordinary winter. In the southern parts of Jackson Hole, where the principal elk herds congregate in winter, the coyote study was less intensive.

Almost without exception, the coyote obtains adult elk as carrion. Such feeding, therefore, means nothing with respect to elk losses. No one familiar with the conditions expects an adult elk to fall prey to a coyote, unless the animal has been greatly weakened by disease or starvation. After observing the animals closely for several years the conclusion seems warranted that elk in normal condition are old enough by winter to be safe from coyotes. There are, of course, exceptions, and at least one instance was reported of a young elk being pulled down in January. In another instance a bull elk and

nine coyotes were noted from an airplane and it was surmised that the coyotes were interested in the elk, but its physical condition could not be ascertained by the brief glimpse from the plane.

Winter killings, however, are rare and cannot be considered to constitute an appreciable drain on the herd. At times in winter several thousand animals—calves, cows, and bulls—assemble on the Biological Survey's Elk Refuge, where they are fed hay. Coyotes have been seen to mingle with them freely without the elk paying them much attention. One coyote was watched nosing about in a meadow, near a feeding bull elk, but the elk seemed entirely undisturbed.

It is significant that on the winter feeding ground of elk the coyotes find carcasses of animals that have died of disease or from accidents. This is undoubtedly the object of their quest among the elk at that time of year. One would be tempted to predict that were an intensive study of coyote droppings made on elk range in winter, elk carrion would be found to constitute the bulk of the food.

It should be remarked that many of the samples here reported, collected on the summer range, reveal remains of elk in summer pelage. In at least two instances the carcasses on which the coyotes had been feeding were located. The cause of death in one case was accidental, in the other it was unknown.

In 94 instances remains of elk calves were found in coyote droppings, but as in the case of all larger species, it is difficult to determine the number of individuals thus represented. It was clear that all the elk-calf hair in a number of feces represented a single animal. Frequently many feces were from the same place, evidently the spot where the calf had been killed and eaten. Many also were observed in the vicinity of such carrion as that of a horse or an adult elk. In one case, 4 feces were found together, all approximately the same age. In addition to elk hair, 3 contained remains of grouse egg, 3 marmot, and 2 pocket gopher. This close association of items in the 4 samples would indicate that only 1 elk calf was involved. In another case 3 feces found in the same place all contained elk-calf hair and fish bones. This again pointed to but 1 calf. Many similar instances were discovered. Considering the wide-ranging habit of the coyote, there are no doubt other duplications in the feces impossible of detection.

It is also difficult in many cases to state whether the elk contents of stomachs and feces represented new kills or carrion. In four cases at least the contents included the hair of both adults and calves, and in 1 case the hair appeared too short to be that of an elk calf after birth. The indications were that these were carrion, from a dead cow elk carrying a calf. In at least 2 cases (Sept. 25, 1928, and Sept. 24, 1929), fresh feces contained elk-calf hair—undoubtedly carrion at that time of year. It should be pointed out that a coyote will eat any decayed or dried remains found at any season.

Some further observations in 2 consecutive years bear on this matter. It was discovered that calves of both elk and moose had been dying shortly after birth, and in the spring of 1931 eight dead elk calves were found, but opportunity was afforded to examine only one of these before decomposition began. While no positive conclusions were reached as to the cause of death, it was determined that natural enemies were not responsible. On the other hand, such

carcasses no doubt to some extent furnish food for carrion eaters. In one case some carnivore had begun eating the carcass. In another, in which a thorough post-mortem examination was made, the dead calf showed no marks of violence. Nearly 2 months later the same place again was visited, and although most of the dried carcass remained, some parts had been carried a distance away and partly eaten, apparently by a coyote. The fact that eight dead calves were counted in a limited area, and that it is difficult to find such carcasses in timbered country, would indicate that the percentage of loss from this unknown ailment was fairly high. In that case, a greater number of feces examined may represent carrion.

Another source of carrion, although no doubt limited, is furnished when a nursing calf loses its mother from some accidental cause. As an example, a young elk calf appeared at a ranger station, alone, weak, and emaciated. The ranger undertook to feed it but it did not survive. On the range the carcass would have furnished carrion for coyotes.

These considerations, therefore, make it extremely difficult to determine what percentage of samples in any collection of stomachs or droppings represents carrion. It seems proper to consider, however, that the remains of elk calves recognized in the 94 samples represented not 94 individuals but conservatively 82, of which 6 can be classed as carrion, 12 clearly representing duplications.

The next consideration is whether this indicates a serious drain on the elk herd. Again it is difficult to obtain satisfactory figures. A. C. McCain, supervisor of Teton National Forest, has for several years accumulated various data through counts of elk in winter, in an effort to throw light on the vexing question of percentage calf crop and losses. During two summers also the writer counted the elk herds, and on each occasion noted the number of calves. During examination of winter-killed elk the presence or absence of a fetus in cows also has been noted. From all these sources attempt has been made to ascertain the maximum calf crop possible and the causes of losses. The results obtained at this stage of the study, however, are by no means accurate and can be used, if at all, only in a general way. Data considered were as follows: (1) Summer observations in only those bands in which all the animals could be counted revealed a total of 1,192 cows and 458 calves; from the number of cows should be deducted the yearlings and 2-year-olds, the percentages of which are obtained roughly from the winter counts; the remainder is the number of cows of breeding age. (2) About 45 percent of the dead cows examined in winter were without calf. (3) A very small percentage of cows, possibly only 0.1 to 0.3 percent, had failed to breed, based on examination of a limited number in the hunting season. The fact that between 40 and 50 percent of adult cows were without calf in winter may be explained by the presence of infectious abortion in the herd. In the winter of 1929-30, through the cooperation of E. S. Cotton, of the Bureau of Animal Industry, agglutination tests were made on blood serum obtained from elk. That winter was favorable for the elk, however, and too few died to permit the collection of many blood samples. Of 9 that were collected, 3 were positive for infectious abortion, indicating 33½ percent, if so small a series can be relied upon.

Field observations, however, supplemented these tests, and each winter a number of aborted fetuses were found—10 or more being found one winter. Considering that such fetuses are not readily found and that ravens often do away with the remains in a short time, it seems safe to conclude that a considerable number of abortions occur. An employee at the Elk Refuge observed one, but when the fetus was sought later in the day, it had disappeared.

It is possible that of the number of dead cows without fetus, a certain percentage of abortions may have been induced by diseases and conditions other than infectious abortion. One cow examined had died of necrotic stomatitis. Only a few feet behind her lay the aborted fetus. In nearly all cases, however, abortion had occurred early enough to leave no easily observed traces in the generative organs. It seems improbable that necrotic stomatitis induces abortion, for of the animals that had died of this disease, at least as many still retained the fetus as had lost it, and in one case, when some healthy cows were detained in an experimental enclosure for a considerable time, one abortion occurred. These animals apparently had no fatal or disabling disease.

Weighing all data, it may be conservatively stated that 60 percent, or possibly less, of the adult cows observed in summer had calves and that in winter between 35 and 40 percent of the cows were without calves. These percentages are so low as to eliminate the possibility that fatal disease is a factor of any importance in abortion. Any difference between the two would represent the calf losses from other factors (here estimated from 5 to 10 percent). Operating in the period while the calf is small and before the animals have banded together, this percentage would probably include deaths from various accidents, including depredations by coyotes and bears, as well as from the unknown fatal disease noted shortly after birth, as above referred to. Though not precise percentages, the figures give the nearest approximation to present conditions that is now possible.

To whatever extent the coyote feeds on elk calves, its habits are harmful. In the light of these considerations, however, it takes its place as one of the lesser factors inimical to elk calves and would appear to play a relatively unimportant part in the productivity of the herd. Were the coyote alone eliminated, or also the bear, the elk problem would still remain, and the number to be eventually allowed hunters would probably be about the same.

MULE DEER

Mule deer (*Odocoileus hemionus macrotis*) remains occurred 20 times, forming 0.83 percent of the items in the coyote diet. When dealing with the large-mammal food of predators it is difficult to distinguish between kills and carrion. Some of the deer were in summer pelage, representing a time of year when the adults can usually take care of themselves. A number of elk and moose, and a few deer, die each summer from various causes, and their carcasses, furnishing food for coyotes, might be represented in any collection of fecal samples.

A large number of deer from the mountains of the Teton Game Preserve migrate eastward to winter in the Shoshone watershed, but

some assemble on the Buffalo Fork of Snake River and neighboring slopes. In this locality a number perish during severe winters, and coyotes are seen feeding on the carcasses. Whether these are kills or carrion in most cases has not been determined. Several captive deer, as reported elsewhere, succumbed to necrotic stomatitis. It has been noted that losses of deer, as well as those of elk, are heavier in hard than in favorable winters. The elk losses are occasioned chiefly by diseases, some being induced by unfavorable food conditions. To what extent the same factors apply to deer is not known. On the other hand, it is definitely known that coyotes will kill deer in winter, and no doubt a certain number of deer losses in severe winters may be charged to these predators. In spite of winter losses, the deer are at least holding their own, and a very definite increase was noted in southern Jackson Hole in the winter of 1931-32.

As previously stated, the deer have not been adequately studied. The present study did not extend to their limited winter range, where there would have been more opportunity for coyote depredations.

MOOSE

Moose (*Alces americana shirasi*) remains appeared only five times in the coyote food samples and these without question were all carrion. Considering the number of moose that die naturally, or are killed by hunters, a larger representation would be expected. One observation may be pertinent. During at least two seasons, when the hunting season for moose opened in the Upper Yellowstone section coyote droppings were often found, many of which were homogeneous and semiliquid, containing no diagnostic hair or bone, evidently the residue of a pure-meat diet. Such meat, without hair or bone, might easily be obtained from a large animal, such as a moose. Moose carcasses, from which the choicest meat had been taken by hunters, were fairly common in the vicinity of Bridger Lake, and on several occasions coyotes and ravens were seen feeding on them. In any case, moose can be in no great danger from coyotes.

ANTELOPE

Remains of antelope (*Antilocapra americana*) were found in three stomachs from Yellowstone Park, under circumstances pointing to the use of antelope remains for bait in trapping. Antelope do not occur in the area that was worked intensively and do not enter the present problem.

BUFFALO

In 10 stomachs from Yellowstone Park, remains of buffalo (*Bison bison bison*) were present, all either carrion or bait. No material is available bearing on possible mortality among new-born buffalo.

MOUNTAIN SHEEP

Three droppings containing evidence of mountain sheep (*Ovis canadensis*) were found in one spot, evidently where the coyotes had been feeding on a single carcass. Whether this was carrion could not be determined. There is no question, however, that coyotes will kill mountain sheep. Several persons have observed them apparently stalking sheep, and in one instance, which was reported from an

authoritative source, a hunter found a freshly killed lamb, evidently the victim of a coyote. Still another instance is that of a ram found on January 17, 1932, at a considerable distance from any cliffs, freshly killed by coyotes. It was so old, however, and its teeth were so greatly worn, that it was referred to by the local game warden as "almost a gummer."

As suggested previously, although some work was done on the mountain sheep range and sheep remains appeared sparsely, it is not felt that the collection of samples is large enough to give a true picture of the relation of the coyote to the species. It appears, however, that the herds are doing fairly well—so well indeed, that hunting seasons have been allowed, with due safeguards against excessive kills, by means of a system of alternating open and closed areas.

DOMESTIC ANIMALS

Remains of domestic cattle appeared seven times, the majority coming from the vicinity of one dead steer, the cause of death of which was unknown. The samples included in the present study represent carrion. Local cattlemen in general do not appear concerned about the coyote, and this predator has rarely been discussed as a possible menace to cattle in this section.

In 27 cases horse remains were found, all carrion. It is the practice to use a horse for bait, not only for trapping but also for shooting coyotes.

BIRDS

In the Jackson Hole section birds appear to form a relatively small proportion of coyote diet.

In the list appeared 36 small birds—ranging in size from that of a junco to that of a robin—and 1 egg, apparently that of a ground nester. Presumably some of the birds also were ground nesters. Occasionally a coyote gets an unusual opportunity to feast on birds. In one place several hundred cliff swallows had been nesting on a high cliff, and in such colonies a considerable number of young birds fall out of the nests. In this case a coyote had apparently visited the place frequently, as indicated by the droppings. With such exceptions as this, the item of small birds in the coyote's diet is, of course, a harmful one.

ROCKY MOUNTAIN JAY

One Rocky Mountain jay (*Perisoreus canadensis capitalis*) was found in one coyote stomach.

MAGPIE

The magpie (*Pica pica hudsonia*) was represented in two stomachs, in one case at least, as bait.

DUCKS

Wild ducks appeared seven times in the material examined. In one case, when feces were found near the Jackson dump grounds in winter, the contents clearly indicated carrion. Duck wings and feathers were noted in various garbage piles. Several fecal samples containing duck remains were found near Bridger Lake. As considerable duck shooting had taken place there each fall during the period of this study, the coyotes had perhaps picked up cripples that

had drifted ashore, or had fed on the garbage around the camp ground. It should be pointed out that there are no extensive duck-breeding places in the area covered by these studies. Even the swamp lands near Jackson on which the ducks nest rather plentifully are not occupied by coyotes so extensively in spring as in winter. Therefore the opportunities for obtaining ducks here are more or less limited. All occurrences of ducks in this study appear to have been carrion.

EARED GREBE

Remains of eared grebes (*Colymbus nigricollis californicus*) were noted three times. It is suspected that hunters furnished the carrion in each case, but no direct information is available on that point. At any rate, the occurrence of this species in this area is insignificant.

GROUSE

The species of grouse involved in this study are the Richardson's and gray ruffed grouse (*Dendragapus obscura richardsoni* and *Bonasa umbellus umbelloides*), and they were noted 34 times—17 adults, 3 young, and 14 eggs. In three cases the adult bird had evidently been captured on the nest, for both bird and egg remains were found. In nine cases it appeared that the eggs only were obtained, since no bird remains were evident. Probably the majority of the eggs taken were in the incubating stage, though the eggs were represented once late in November, probably old shells left by hatched chicks. In general, grouse of both species were found rather plentiful during the investigation. In summer, coveys of Richardson's grouse were of frequent occurrence in the mountains. Two and three coveys of birds were often found during a day's ride, being casually observed without seeking them. On one or two occasions in spring at least four cocks were heard hooting at one time in various directions. Similarly, from one place could be heard several ruffed grouse drumming. The latter species are more restricted in range, being limited in the main to brushy banks of streams and bottom lands. The grouse items on the diet must be listed as harmful, though the depredations of coyotes do not materially reduce the grouse population in the localities studied.

DOMESTIC POULTRY

Poultry used as bait was found in one stomach. No other occurrence was recorded, and serious depredations on poultry in Jackson Hole have rarely been reported. On one small poultry farm, however, at the base of a timbered mountain near Jackson, where a large flock of chickens and usually a number of turkeys were kept, apparently the chickens were molested little, if at all, by coyotes, though one year a band of turkeys wandered into the timber and 11 or 12 were killed by these predators. Apparently this was the only case of a serious depredation.

FISHES

Seventeen fishes, all trout (*Salmo* sp.), are represented in the coyote-diet samples, found chiefly at Two Ocean Lake and Bridger Lake. No doubt the coyotes had picked up remains left by fishermen at these popular fishing places, although the coyote can pick fish out of shallow streams. Were the coyotes spending much time in fishing, one would expect to find at least some remains of suckers.

In the winter of 1931-32 a forest ranger in the Upper Yellowstone section found a considerable number of trout killed by the falling ice in a spring, where the water level had been lowered. Tracks showed that coyotes were feeding regularly on the dead fish, and the incident illustrates one source of fish for the coyote diet. Fish seems an unusual and unimportant item in the coyote diet, and in the present case it should be considered of neutral importance.

INVERTEBRATES

GRASSHOPPERS

Outstanding in the invertebrate food of the coyotes in the material examined are grasshoppers (Orthoptera). These occurred 41 times, from 1 to 200 or more and totaled roughly about 505. Long-horned and short-horned grasshoppers of several species are represented, of which the following were determined by T. H. Hubbell, of the University of Michigan: A large dectid, probably *Anabrus simplex*; *Melanoplus bivittatus*; and *Melanoplus* sp. Grasshoppers are not ordinarily a serious menace to agriculture in the mountain areas here considered, and apparently they do not bulk large in the coyote's diet. Their consumption by the predators is not considered important, therefore, in this locality. That this item is not accidental, however, is shown by the fact that more than 200 grasshoppers were found in one stomach. The coyote has often been noted deliberately seeking these insects in mountain meadows, and makes them a regular, though fairly small, item in its bill of fare.

MOLE CRICKET

Two large mole crickets (Orthoptera) were found in one stomach. Their consumption would appear to have no economic significance.

BEETLES

Beetles (Coleoptera), though very acceptable to the coyote, are not so readily obtained as grasshoppers. At least 66 of several species were distinguished in 14 samples, though only one was tentatively determined, namely, *Carabus taedatus*. These can probably be considered a neutral item in the diet.

OTHER INSECTS

Hymenopterans in the fecal samples consisted of 2 bumblebees and 1 ant, and dipterans comprised 1 fly and 1 bot (*Cuterebra*). This miscellaneous assortment only serves to indicate the coyote's taste for insects when obtainable. The bot was no doubt eaten with a rodent, the remains of which were found in the same sample.

SNAILS

In two droppings were found remains of snails (*Oreohelix depressa*), determined by Calvin Goodrich, of the University of Michigan. This is an unimportant item, but interesting, as indicating the varied taste of the coyote.

VEGETABLE MATTER

In some localities the coyote seeks and finds a considerable variety of berries and other forms of vegetation. In Jackson Hole, however, such food is not abundant except in restricted areas, which may account for its meager representation in the droppings examined.

GRASSES

In 20 samples it was shown that the coyote had eaten a wad of green grass (Gramineae). Apparently the animal had chosen a broad-bladed variety, probably a brome, or possible wheatgrass, but not such fine-leaved varieties as *Poa*. It is commonly believed that when a dog or wolf eats grass it has some slight ailment and thus exhibits a clever instinct for seeking a remedy. These studies indicate, however, that green grass forms a regular part of the diet, as beneficial, no doubt, to the animal as is lettuce or spinach to man, but there is no implication of self-medication. In numerous samples were found the root bulbs of onion grass (*Melica* sp.). These were invariably associated with the remains of pocket gophers, however, and were clearly the cheek-pouch contents of these rodents.

PINE NUTS

Pine nuts (*Pinus albicaulis*) occurred in nine fecal samples. Herb Whiteman, successful trapper in northern Jackson Hole, stated that in winter he has seen coyotes far back in the mountains digging down through rather deep snow for these nuts. This food is generally confined to the high ridges, approaching timber line. Pine nuts would be an economically neutral item in the diet.

SERVICEBERRY

Serviceberry (*Amelanchier* sp.) was found twice. Were observational efforts concentrated in the lower foothills, particularly in southern Jackson Hole, it would no doubt be found that this fruit is very acceptable to the coyote, but over the whole section it proves to be an insignificant item in the food.

MISCELLANEOUS NONFOOD ITEMS

Pieces of rag were found in four samples. In one, there were two pieces of a shirt, with a button and the brand, thoroughly impregnated with horsehair. Possibly this had been used as a bandage on a horse, thus producing an attractive flavor. One rag was a piece of towel. Two pieces of heavy harness leather, one of them about 1½ inches square, with a copper rivet, were found in one stomach. Another contained bits of wood and paper.

CONCLUSIONS

Of the long list of items in the coyote's year-long diet in the Jackson Hole country, 70.29 percent may be credited to the animal as indicating economically beneficial feeding habits; 18.22 percent may be classed as neutral, and only 11.49 percent may be charged against the coyote. Other neutral items, including carrion and other abnormal foods, such as garbage, offal, and bait material, are left out of the

consideration as not indicative of predatory habits. The balance is overwhelmingly in favor of the coyote in this locality.

That some of the rodents consumed are only mildly destructive in this area is beyond question, and this fact tends somewhat to discount the beneficial score credited to the coyote. Moreover, rodents in themselves are not everywhere harmful to human interests—much depending upon local circumstances. For instance, when rodents are present in only moderate numbers, they may be an important source of food for fur bearers, certain birds, and other valuable and interesting flesh-eating animals, the competition of which offsets the value of the depredations of the coyote.

Even if the value of the beneficial items were thus discounted and some assigned to the neutral category, there would still remain a positive item of only about 11½ percent to the coyote's discredit in this section. Though even a small unfavorable percentage may sometimes have serious consequences, the statistics on losses of elk calves in Jackson Hole reveal that those chargeable to coyotes are not serious, and that while coyotes (as well as bears) to some extent persistently prey on elk calves, this does not become a serious factor in the elk-management problem. Winter killing, the ravages of disease, and hunting constitute the principal drain on the elk herd, and even though the coyotes were entirely eliminated, it is improbable that any material increase in the herd would result thereby or that the problems in elk management would be materially alleviated.

The present study has not revealed that coyotes are a serious menace to the deer or mountain sheep, although more work is considered necessary for assembling precise data on the ecology of these two animals. It is possible that a greater number of coyote droppings collected on the range of mountain sheep would show a somewhat increased percentage of these mammals in the diet.

On the other hand, the coyote is found to have certain positive values other than those resulting from its food habits. The fur value comes readily to mind. Each winter several hundred coyotes are killed in Jackson Hole, and many residents welcome the income derived from the sale of the pelts. The animals are obtained chiefly by trapping and shooting, and to a less extent by poisoning.

In the Jackson Hole section direct agricultural interests are interfered with by coyotes only to a limited extent. The principal consideration is the alleged damage by these predators to the interests of hunters. Many of the elk hunters of this section, however, enjoy the presence of the coyote and are opposed to its elimination. This may be explained by the stress placed on recreational values in this area, where dude ranching holds an important place, as much as by the factor of fur values. In any case, when an animal appears to be destructive only to a limited and tolerable degree, the other values can be allowed to enter the consideration.

To sum up, the fur value of the coyote, the potential value of its beneficial habits, the fact that the animal is intrinsically interesting and has a scientific value, and what may be termed an inspirational value, however much derided, can be given considerable weight. After all, the wildlife question must resolve itself into sharing the values of the various species among the complex group of participants in the out-of-door and wilderness wealth, with fairness to all groups.

Under such considerations, with possible local exceptions, the coyote deserves to remain a part of the Jackson Hole fauna, with only a minimum of control, and that only in the case of unusual local situations. In Yellowstone National Park it has been the practice of park rangers to shoot coyotes when necessary instead of trapping them.

The writer's investigations corroborate the wisdom of leaving to the efforts of local trappers the control of the coyote in the Jackson Hole section, which is in reality chiefly a wilderness area. In view of all these considerations, this would appear to be a fair method of dealing with the coyote in Jackson Hole, a procedure fair to all who are interested in this animal, particularly to the local residents, many of whom are opposed to its elimination from the area. Each winter the animals are there sought for their fur. It seems desirable that the Bureau's policy be continued.

